

BIOLOGICAL EVALUATION OF GYPSY MOTH

at

Catoctin Mountain Park

Prepared by

Rodney L. Whiteman
Forester
and
Bradley P. Onken
Entomologist

USDA Forest Service
Forest Health Protection
Morgantown, WV 26505

January
2003

ABSTRACT

In the Fall of 2002, USDI Park Service personnel and USDA Forest Service personnel conducted a gypsy moth egg mass survey at Catoclin Mountain Park. The purposes of this survey were evaluate the efficacy of last year suppression project and to assess the potential for defoliation and the need for treatment in 2003. Current populations are sufficient to cause noticeable defoliation on approximately 67 acres. Treatment is recommended to prevent defoliation and possible tree mortality.

METHODS

Gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. At each sample point, a 1/40th acre fixed radius plot was established. The plots consisted of a tally of all new (2002) egg masses observed on overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre.

Egg mass length was measured at most of the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity. The average egg mass length (measured in millimeters) and egg mass density (egg masses per acre) were used to estimate defoliation potential (Liebhold et al., 1993).

RESULTS

The location of the survey plots are shown in Figure 1. The summarized results of the survey are presented in Tables 1. Egg mass densities throughout CMP ranged from 0-6,120 and averaged 500 egg masses per acre. The only area that is heavily infested by gypsy moths is located east of Chimney Rock. Overall egg mass length tended to be moderate in size, ranged from 10-30 mm and averaged 23 mm.

The 401 acre gypsy moth suppression project conducted in May of 2002 using Gypchek provided good results. Only 44 acres (11 percent) of the treatment area was defoliated (Figure 2). Overall egg mass densities within the treatment area were reduced 44 percent from the pre-treatment level (2001) of 1,644 to the current are post-treatment level of 998 egg masses per acre. Most of the new egg masses are limited to a 55 acre area east of Chimney Rock. Outside of this area, egg masses were detected on only one out of eight plots. Only 55 acres (14 percent) out of the 2002 treatment area needs to be re-treated in 2003.

DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as; light (1-30 percent); moderate (31-60 percent); and heavy (61-100 percent).

The survey results indicate that a 67 acre area of moderate defoliation is likely to occur at Catoctin Mountain Park in 2003 (Figure 3).

This defoliation prediction is further supported when egg density is also used as a means of estimating gypsy moth population densities. Moore and Jones (1987) found that estimating the mean fecundity would increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and predicting defoliation.

Using Liebhold's model, Figure 4 shows how this information can be used to correlate the predicted defoliation of an area. Accordingly, the estimated egg mass density of 1,793 egg masses per acre (average egg mass density in the 67 acre area east of Chimney Rock) x 23 mm (average egg length) translates to a projected defoliation level of about 40 percent (moderate defoliation). Because egg mass densities and host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately moderate throughout this area of CMP.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be building and healthy throughout most areas surveyed. The overall average egg mass length is 23 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious sign of stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. There was no evidence that either one of these entomopathogens had significant impacts at CMP in 2002. Although it is still possible that either the gypsy moth fungus or the NPV could cause a general collapse next year, it is not likely to occur prior to a significant defoliation event occurring in 2003.

Predicting the extent of tree mortality that would result after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light-moderate defoliation (< 60 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems. A severe drought was experienced in this portion of Maryland during the summer months in 2002. Also, approximately 19 acres of moderate, and 27 acres of heavy defoliation were detected at CMP in 2002, (Figure 2). All 46 acres of defoliation are located within the 2003 proposed treatment block.

The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) and the Cuyahoga Valley National Park (2002) provide examples of potential tree mortality. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28) percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak sawtimber and 14 percent of the total oak poletimber occurred after one year of moderate to heavy defoliation. At Cuyahoga Valley National Park following one year of heavy defoliation, significant mortality occurred in approximately 25 percent of the defoliated areas. In the mortality areas, oak mortality ranged from 22-98 percent and averaged 54 percent. In these examples, droughty conditions in 2003 likely contributed to the level of mortality.

Based on observations of the existing health of the forested areas at CMP and the factors mentioned above, significant tree mortality is likely to occur in this 67 acre block if it is defoliated. Droughty conditions in 2003 would undoubtedly intensify the mortality.

Management Options

For 2003, two management options have been evaluated for managing gypsy moth populations at CMP. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage and prevent subsequent tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga*. In areas with defoliating levels of gypsy moth populations (greater than 750 egg masses per acre) viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels.

Even though gypsy moth populations are fairly static and are only moderate in size, it is not possible to predict if the population will collapse or if the collapse will occur prior to a defoliation event.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al. (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that moderate defoliation will occur in a 67 acre area at CMP in 2003.

Microbial Insecticide Option

Btk: The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringiensis* variety *kurstaki* (*Btk*). This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis, which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al. (1996) in West Virginia. Miller's study involved a large-scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1-year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½-1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely.

Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological

factors such as feeding activity and weather conditions, it has been difficult to project treatment efficacy. Most often foliage protection is achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas may need to be treated again the following year.

The normal application rate of Gypchek is 2×10^{11} occlusion bodies (OB's) per acre applied in two applications, or a single application at 4×10^{11} OB's. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There are, however, sufficient quantities of Gypchek currently available for 2003 should this insecticide be preferred for use at CMP.

Alternatives

With the previously described options in mind, the following alternatives are offered.

- | | |
|---------------|--|
| Alternative 1 | - No action |
| Alternative 2 | - One aerial application of <i>Btk</i> at the rate of 36 BIUs in a total mix of $\frac{3}{4}$ gallon per acre. |
| Alternative 3 | - Two aerial application of <i>Btk</i> , as in alternative 2, applied 4-7 days apart. |
| Alternative 4 | - One aerial application of Gypchek at the rate of 4×10^{11} OB's in a total mix of 1 gallon per acre. |
| Alternative 5 | - Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of 1 gallon per acre, applied 3-5 days apart. |

RECOMMENDATIONS

As previously stated, gypsy moth populations are sufficient to cause moderate defoliation on 67 acres at CMP in 2003 (Figure 3). To protect host tree foliage and prevent subsequent tree mortality, our recommendation is Alternative 4 (a single application of Gypchek). This recommendation is based on the following conditions:

1. The use of Gypchek minimizes the risk to other non-target organisms including lepidopteran caterpillars.
2. A single application of Gypchek will likely provide adequate foliage protection and reduce the existing population below the treatment threshold throughout most, if not all, of the treatment area.
3. The cost of a single application of Gypchek is about one half that of a double application of Gypchek.

Only small and scattered areas of defoliation, if any, are expected elsewhere at CMP in 2003.

REFERENCES

- Allegheny National Forest, Warren, PA. 1988. Gypsy moth caused oak mortality – Allegheny National Forest, 1988. USDA Forest Service internal report prepared by Forest Pest Management staff, Morgantown, WV. Unp.
- Cuyahoga Valley National Park, Brecksville, OH. 2002. Oak Mortality Evaluation. Cuyahoga Valley National Park, 2001. USDA Forest Service Internal report prepared by Forest Health Protection staff, Morgantown, WV. Unp.
- Liebhold, A.M., Simons, E.E., Sior, A., and Unger, J.D. 1993. Forecasting defoliation caused by the gypsy moth from field measurements. *Environ. Entomol.* 22(1): 26-32.
- Miller, J.C. 1990. Field assessment of the effects of a microbial pest control agent on non-target Lepidoptera. *American Entomologist* 36:2, 135-139.
- Moore, K.E.B. and Jones, C.G. 1987. Field estimation of fecundity of gypsy moth (Lepidoptera:Lymnatriidae). *Environ. Entomol.* 16: 165-167
- Sample, B.E., Butler, L., Zivkovich, C., Whitmore, R.C., and Reardon, R.C. 1996. Effects of *Bacillus thuringiensis* Berliner var. *Kurstaki* and defoliation by gypsy moth [*Lymantria dispar* (L.) (Lepidoptera:Lymnatriidae)] on native arthropods in West Virginia. *The Canadian Entomologist* 128:573-592.
- West Virginia Division of Forestry. 1997. *In 1997 Cooperative State-County-Landowner Gypsy Moth Suppression Program in West Virginia.* 3p. (Brochure).

**Table 1. Results of the gypsy moth egg mass survey at
Catoctin Mountain Park, Fall 2002**

Plot Number	Number EM/Acre	Plot Number	Number EM/Acre
1	0	21	0
2	0	22	0
3	0	23	120
4	0	24*	800
5	0	25*	800
6	0	26*	1,000
7	0	27*	840
8	0	28*	2,080
9	0	29	0
10	0	30	0
11	0	31	0
12	0	32	40
13	0	33	0
14	0	34*	1,000
15	0	35*	2,120
16	0	36*	80
17	0	37*	6,120
18	0	38*	1,920
19	0	39*	2,960
20	0	40	120

Overall egg mass/acre range = 0-6,120
Overall egg mass/acre average = 500

Egg mass size range (mm) = 10-30
Egg mass size average (mm) = 23

* = Located within proposed treatment area

Egg mass/acre range in proposed treatment area = 80-6,120
Egg mass/acre average in proposed treatment area = 1,793

Figure 1.--Gypsy moth egg mass survey plot locations
at Catoctin Mountain Park, Fall 2002.

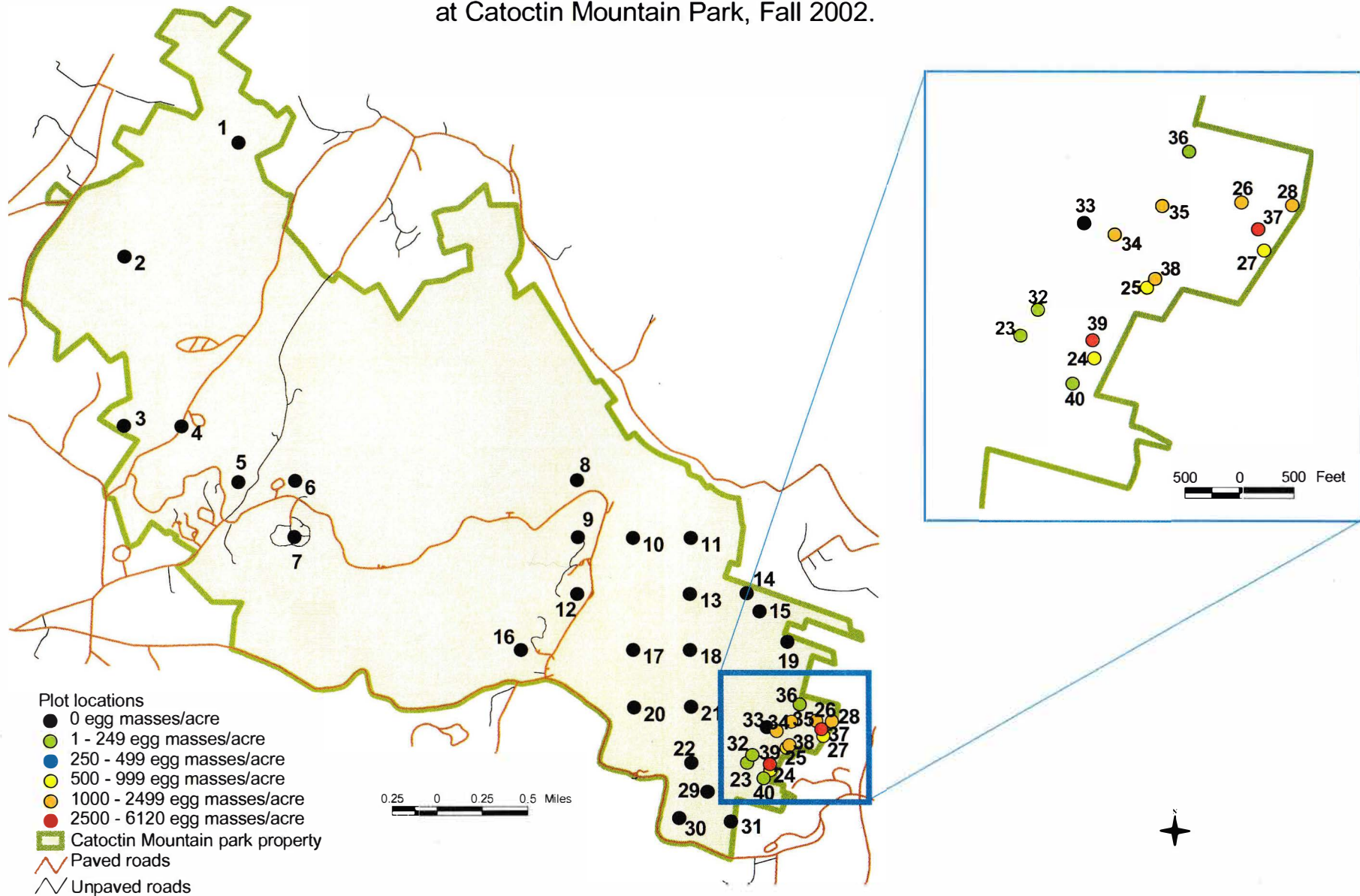


Figure 2. -- Results of the gypsy moth defoliation survey conducted on June 17th, 2002, along with the 2002 gypsy moth treatment blocks at Catoclin Mountain Park.

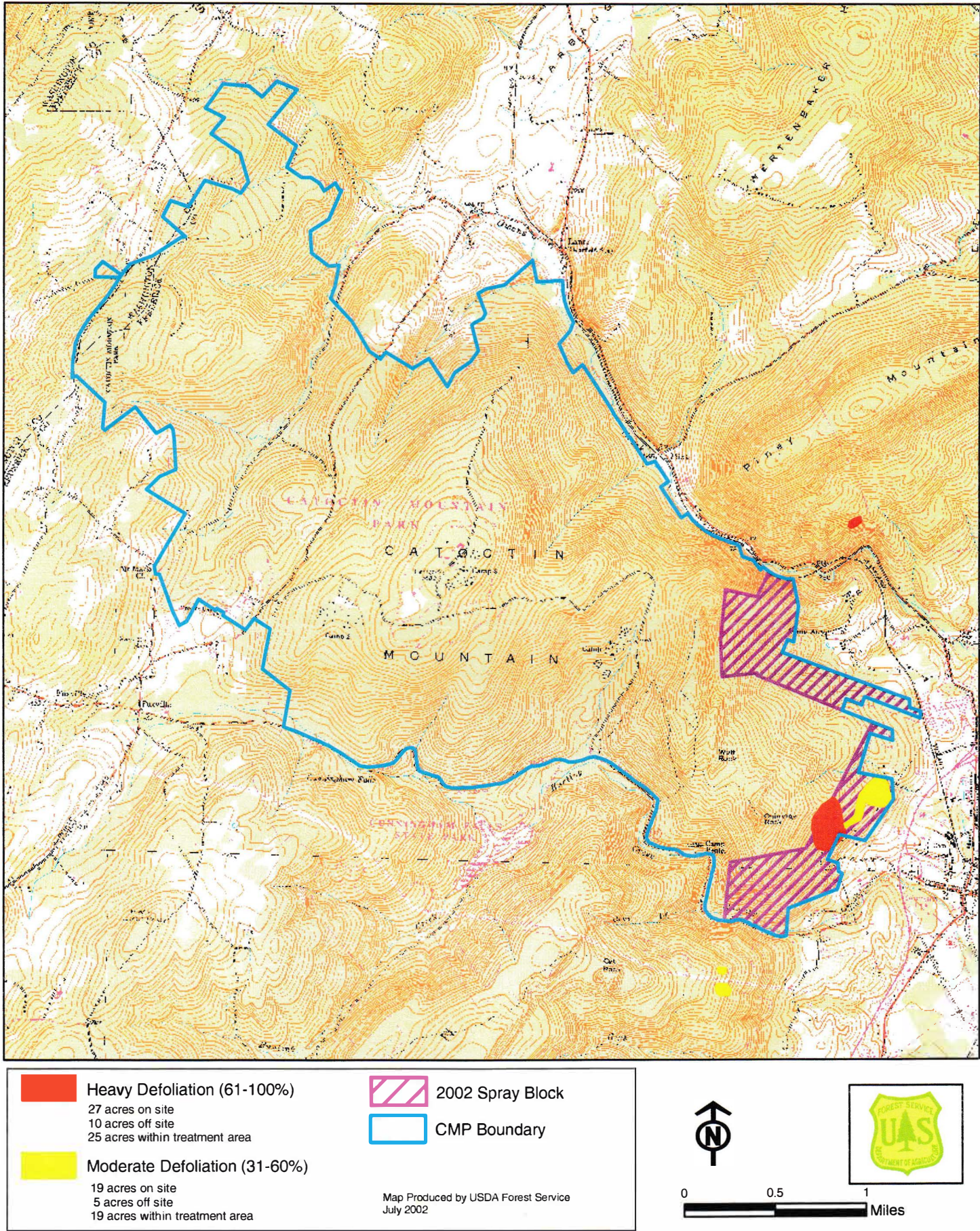


Figure 3.--Area where defoliation is likely/proposed treatment block at Catoclin Mountain Park in 2003.

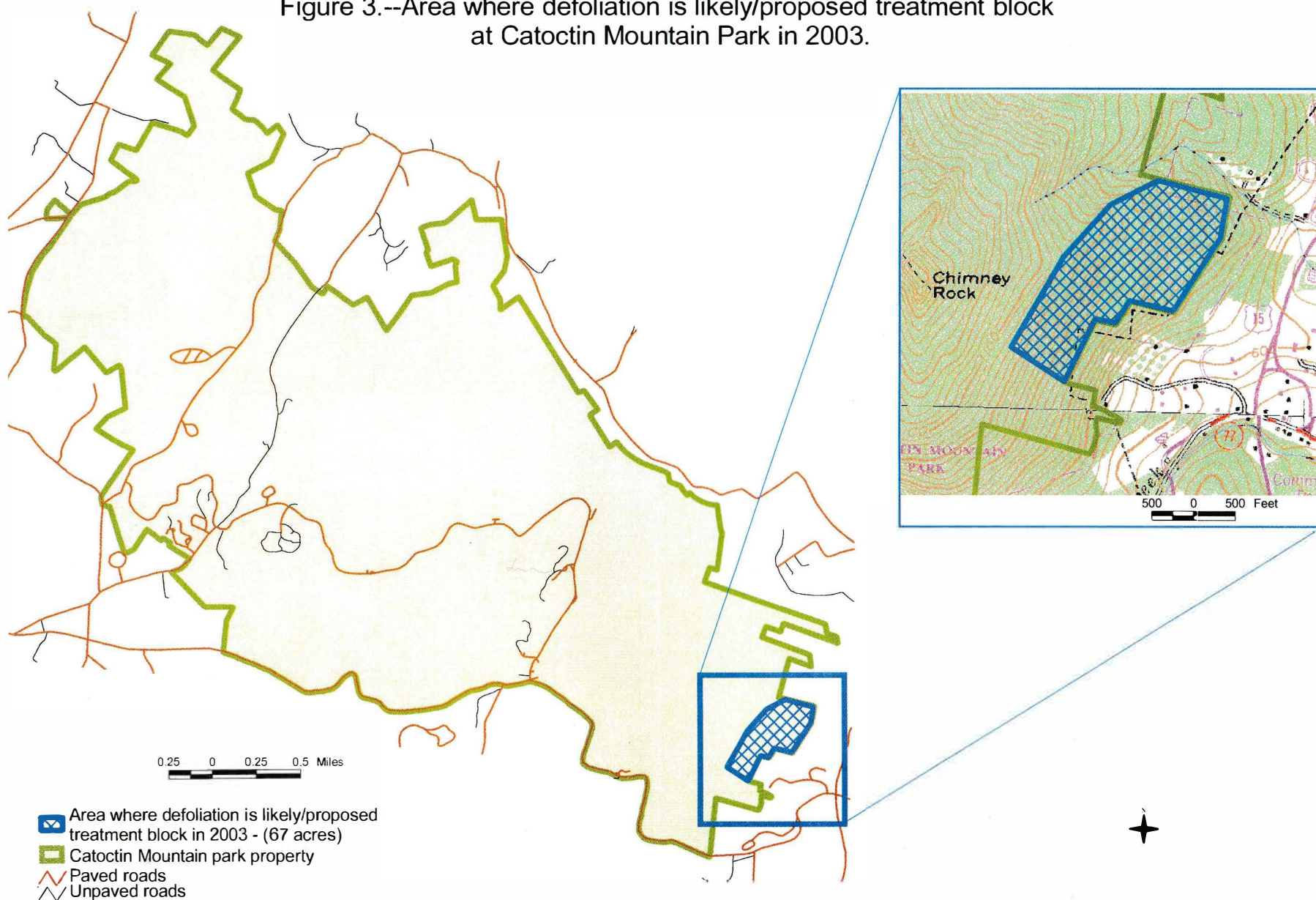
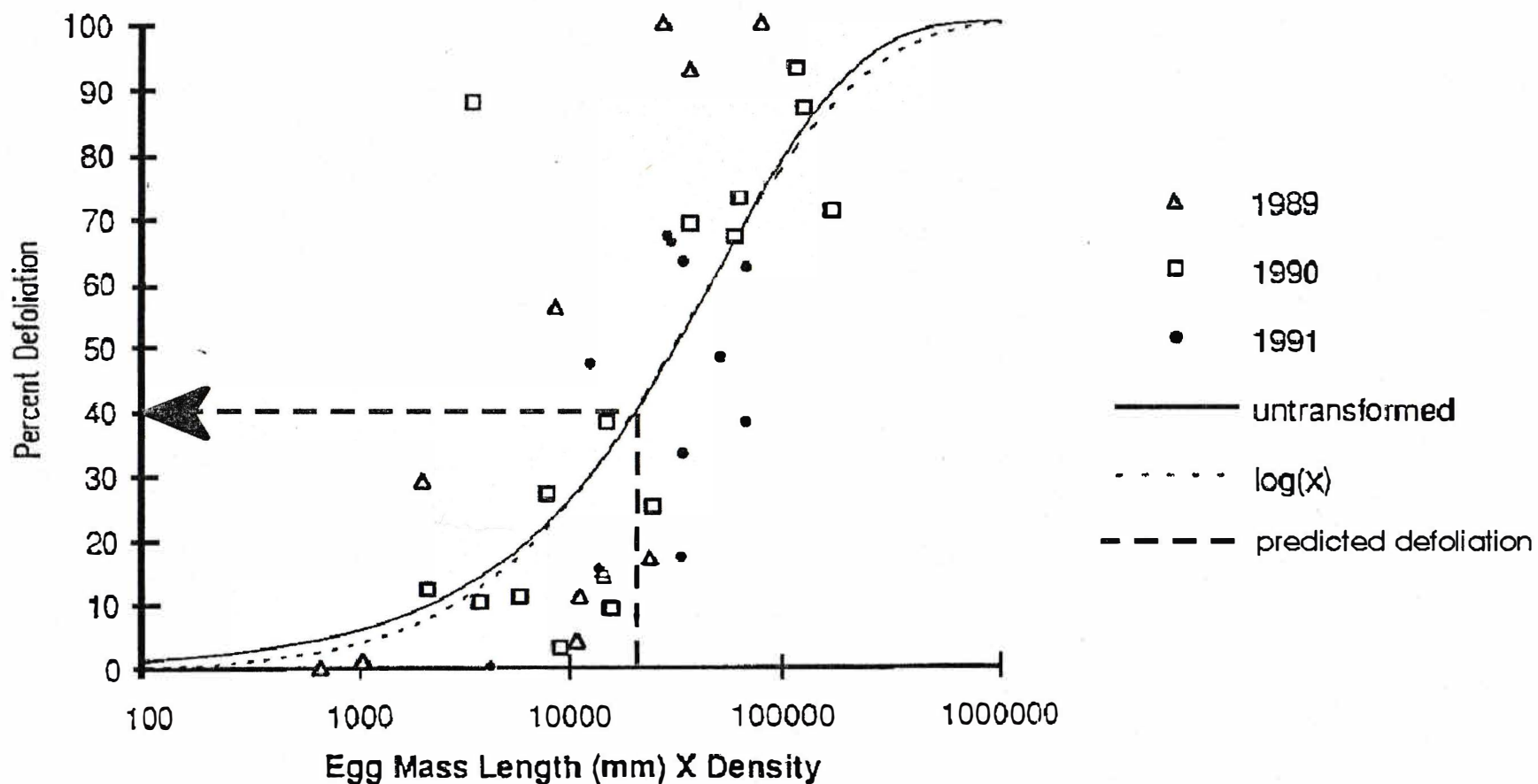


**Figure 4.--Predicted defoliation in 67 acre area east of Chimney Rock
at Catoctin Mountain Park in 2003.**



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation.
Extracted from Liebhold et al. (1993).



File Code: 3400

Date: January 21, 2003

Mr. Mel Poole
USDI National Park Service
Catoctin Mountain Park
Thurmont, MD 21788

Dear Mr. Poole:

Enclosed is the gypsy moth biological evaluation for Catoctin Mountain Park.

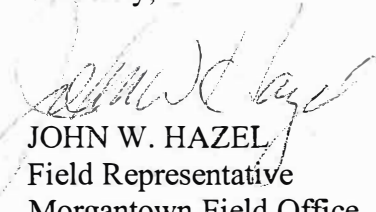
In brief, gypsy moth populations are sufficient to cause moderate defoliation on 55 acres east of Chimney Rock. We are recommending a single application of Gypchek in this area. With proper application, gypsy moth defoliation should be minimal at Catoctin Mountain Park in 2003.

The results of the 2002 suppression project using Gypchek were good. Only 11 percent of the treatment area was defoliated and populations have been reduced 44 percent from the pre-treatment levels. Only 14 percent of the 2002 treatment areas qualify for treatment in 2003.

We would like to thank your staff for conducting the preliminary egg mass survey.

Please contact Rod (304-285-1555) or Brad (304-285-1546) if you have any questions concerning this gypsy moth biological evaluation.

Sincerely,



JOHN W. HAZEL
Field Representative
Morgantown Field Office

Enclosure

cc: James Voight, CMP
Jil Swearingen, CUE
Robert Tichenor, MDA
Betsie Handley, MDA
Noel Schneeberger, AO

JWH/RLW/blm

